Session II

Population dynamics, sampling and damage of *Bemisia tabaci* in agricultural systems

Naranjo, S.[1]; Ellsworth, P.[2]; Cañas, L.[2]

[1] USDA-ARS, 4135 E. Broadway Road, 85040 Phoenix, AZ, USA
[2] University of Arizona, 37860 W. Smith-Enke Road, 85239, Maricopa, AZ, USA

Bemisia tabaci was described over 100 years ago as a tobacco pest in Greece and has since become one of the most important pests of world agriculture. In addition to direct feeding damage, the insect vectors a number of devastating plant viruses, causes debilitating plant disorders of unknown etiology and, by the excretion of honeydew, reduces the quality of harvested products. In the past two decades, the pest has invaded every continent in the world except Antarctica. Considerable progress has been made in developing sampling methods and plans for both research and pest management application in affected crops. Advances in sampling on cotton will be highlighted. A combination of biological and ecological characteristics such as high reproductive rates, polyphagy and dispersal permit rapid population growth; however, factors governing the population dynamics of *B. tabaci* are poorly understood. We will emphasis cohort-based life table studies as a means of identifying, estimating and interpreting mortality factors affecting populations of *B. tabaci* on a variety of host plants. In cotton, survival from egg to adulthood ranged from 0-27% and was < 10% in the majority of cohorts. Survivorship in broccoli, cantaloupe and alfalfa averaged 16, 29 and 14%, respectively. Predation by sucking predators and dislodgment were major sources of egg and nymphal mortality. Parasitism by aphelinid wasps was generally low. Most mortality forces act in a density-independent manner, however some weakly density-dependent effects occur. Relatively little mortality from any source is completely irreplaceable. In cotton the highest rates of irreplaceable mortality were consistently from predation and dislodgment. Many factors contribute to high levels of mortality in populations of *B. tabaci*. This understanding will aid on-going efforts to develop more ecologically-based management strategies for this pest in all affected cropping systems.

Ecological implications of the unique *Bemisia* - plant interactions

Inbar, M.

University of Haifa, Oranim, Department of Biology, 36006, Tivon, Israel

The constitutive and induced host plant chemical defenses can substantially reduce the population levels (and damage) of phytophagous insects. Insects that can avoid, overcome, or even utilize such defenses gain a significant adaptive advantage. A recent set of greenhouse and field experiments integrated with biochemical and molecular methods suggest that whitefly (*Bemisia* sp.) exercise special relationships with their host plants. For example, feeding of the silverleaf whitefly induces specific defensive squash genes (SLW1 and SLW3). It has been found that defense responses of cotton and tomato, which were induced with elicitors, artificial wounding and insect herbivory, that usually have negative effect on various insects, have no effect on whiteflies. Furthermore, plant responses following whitefly feeding ends in asymmetric, direct and plant mediated, interspecific competition that reduces the performance of other insects that feed simultaneously with whiteflies on the same host plant. The mechanisms behind this phenomenon are not known but should indicate that *Bemisia* have remarkable physiological abilities. *Bemisia* - plant relationships seems to be more complicated and involve multitrophic levels. It has been shown that geminivirus increases the fecundity of *Bemisia*. Thus, *Bemisia* and viruses manipulate the host plant to their own benefit suggesting mutualistic relationships.

Microsatellite evaluation of *Bemisia tabaci*- an Old World perspective

De Barro, P.[1]; Scott, K.[2]; Graham, G.[2]; Lange, C. L.[2]; Schutze, M.K.[2]

[1] CSIRO Entomology, 120 Meiers Road, 4068, Indooroopilly, Australia
[2] University of Queensland, Centre for Identification and Diagnostics, School of Life Sciences 4072 Brisbane, Australia

Bemisia tabaci is a globally distributed species complex containing 7 distinct population groupings. However, from an ecosystem level management perspective this is perhaps irrelevent and a distraction. Our work with microsatellites has shown that populations of the same biotype can demonstrate considerable differences in allele frequency at geographic scales ranging from global down to individual farms and fields. These patterns can be used to resolve the patterns of movement of geminivirus, sources of infestation and the potential for the spread and exchange of resistance genes across regions. Our research focuses on *B. tabaci* in Asia, but provides insights that could be applicable to other regions.

Ecological data of *Bemisia* spp. (Homoptera: Aleyrodidae) during nine years (1993-2001) in three different crops in the southern region of Granma province, Cuba

Fernández, J. L.[1]; Landvogt, C.[2]; Gonzalez, M.[3]

[1] Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Departamento de Zoología. Museo de Historia Natural "Tomás Romay". José A. Saco # 601, esq. Barnada.,90100 Santiago de Cuba, Cuba

[2] Universidad de Osnabrück, Fachhochschule Osnabrück, Osnabrück University, Osnabrück, Germany

[2] Estación Territorial de Protección de Plantas de Manzanillo, Jesús Menéndez esq. A 1era, 87510 Manzanillo, Cuba

Ecological information about *Bemisia* spp. populations during nine years on three different crops in the southern region of Granma province (Cuba) was analyzed. The yearly and monthly averages of percent of distribution (% D) and index of affectation (IA) of the pest for each crop were correlated with sown area and weather factors (rainfall, average, minimal and maximal temperatures) in simple and multiple lineal regressions. Tomato was far more attacked than bean and squash, even when it had the smallest cultivated area. Differences were also statistical significant between years for each single crop. In tomato the pest reached a first maximum in October-November and a second one in March-April. For beans monthly data show a main maximum between January and March, a second one in most cases in May-June and a last peak in September-November. For squash the pest was far less important, with two peaks at the beginning and the end of the year; but in half of the years there was only one maximum or no pest at all. IA and % D were significantly correlated in all cases, but for tomato and beans other factors were more important. The relationships between sown areas and the pest were not significant for beans and squash, but it significantly explained 12% of distribution and 29% of IA for tomato, showing its importance as a major host plant. Maximum temperature had a significant influence on the pest in tomatoes and beans, while minimum temperature was only significant for tomatoes. When all weather factors are put together they explained 43 and 52% of the IA for tomatoes and beans, but just 24% for squash. The highest correlations resulted in the regression analyzes when sown area and % D were added to weather data. It is discussed the importance of ecological data analized for pest management and forecasting.

Spatial distribution and sampling of mixed populations of *Bemisia tabaci* and *Trialeurodes vaporariorum* in winter tomato crops under greenhouse

Arnó, J.[1]; Albajes, R.[2]; Gabarra, R.[1]

[1] IRTA-Centre de Cabrils, Departament de Protecció Vegetal, 08348 Cabrils-Barcelona, Spain
[2] Universitat de Lleida, Centre UdL-IRTA, Avinguda Alcalde Rovira Roure 177, 25006 Lleida, Spain

Studies were conducted to provide more information on the distribution of eggs and nymphs of *Trialeurodes vaporariorum* and *Bemisia tabaci* in tomato plants, with the aim of defining a sampling unit to estimate mixed populations of both whitefly species on winter greenhouse tomato crops. Experiment was carried out during winter 1992-93 in two commercial greenhouses in the south east of Spain. Leaflets were taken at fortnight intervals along the whole crop season from the top, middle and bottom strata of the tomato plant. Number of eggs and nymphs (late 3rd, 4th instars and pupae) of each species were counted in each leaflet. Results showed that eggs of *T. vaporariorum* are mainly located at the top stratum of the plant while *B. tabaci* eggs can be found mainly in the middle stratum. Nymphs of both species are mainly concentrated in the bottom stratum of the tomato plant. Three sampling units were compared, in terms of cost-efficiency, to optimize the estimation of nymphs and eggs densities of both whitefly species: (1) a whole-leaflet, (2) one 1.15-cm diameter disk and (3) two 1.15-cm diameter disks. Disks were cut at random from the leaflet. According to the results, we conclude that the most appropriate sample unit to estimate nymphs density of *B. tabaci* and *T. vaporariorum* is a whole leaflet from the bottom stratum of the plant. By contrast, the most advantageous sampling unit to estimate egg density is one disk of 1.15-cm diameter cut at random from a leaflet collected from the top stratum of the plant.

Distribution pattern of *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) and its parasitoids *Eretmocerus* spp. and *Encarsia* spp. (Hymenoptera: Aphelinidae) in cotton, Cukurova, Turkey

Karut, K.; Sekeroglu, E.

Cukuroava University, Agricultural Faculty, Department of Plant Protection, 01330 Adana, Turkey

Cotton is one of the most important crops in Cukurova, Turkey. The growing season is from late March to late September. Many pests attacks this crop but, under irrigated conditions, *Bemisia tabaci* is the key pest causing economic damage and yield reduction. Plants were sampled in 1999 and 2001 to determine the distribution pattern of *B. tabaci* and its parasitoids, *Eretmocerus* spp. and *Encarsia* spp. Whitefly adults were counted by the leaf turn method on a random selected leaf from the top, middle and bottom part of the plant and also on individual mainstem leaves from nodes 2 through 8. Whole plants were examined for eggs, nymphs and parasitized pupae. We looked at 3 parameters to describe the distribution pattern of whitefly and parasitoids life-stages: (1) the leaf position with the highest proportion of a particular stage, (2) the leaf position where insect counts were best correlated with counts on the whole plant; and (3) the coefficient of relative variation. These parameters changed throughout season. For whitefly eggs, were associated with leaves at nodes 2, 3 and 4; for whitefly nymphs with leaves at nodes 4, 5, 6 and 7; and for immature parasitoids with leaves at nodes 8, 9, 10 and 11. Based on Taylor's power law and precision, the most efficient leaf to sample is the 3rd for eggs, the 5th for nymphs, and the 10th for immature parasitoids. Adults were consistently more abundant on top than on middle or bottom leaves and the most efficient leaves to sample were the 3rd or 4th in the mainstem.

Augmenting the activity of cassava whitefly parasitoids by intercropping cassava with sweetpotato

Semaganda, R.[1]; Gerling, D.[2]; Legg, J.P.[3]; Kyamanywa, S.[1]; Adipala, E.[1]

[1] Makerere University, P.O Box 7062 Kampala, +256 Kampala, Uganda
[2] Tel Aviv University, Ramat Aviv 69978, 972 Ramat, Israel
[3] International Institute of tropical Agriculture, IITA-ESARC, P.o Box 7878 Kampala, +256 Kampala, Uganda

Surveys are being carried out in four contrasting agroecologies to determine the temporal and spatial distribution of sweetpoatato whitefly parasitoids. In addition, cassava/sweetpotato intercrop trials have been carried out in Namulonge - Uganda. Treatments include sole cassava and sweetpotato blocks as well as intercropped cassava and sweetpotato. Data on adult whitefly, normal 4th instars and parasitized nymphs have been collected every two weeks. However, for this presentation, data for the survey and preliminary studies on stratification of sweetpotato whitefly eggs, instar and parasitized nymphs will be presented.

Behaviour of *Bemisia tabaci* on diseased and healthy cassava plants in relation to the spread of cassava mosaic disease

Omongo, C. A.[1]; Colvin, J.[2]; Legg, J. P.[3]; Cooter, R. J.[4]; Thresh, J. M.[4]

[1] Namulonge Agricultural and Animal Production Research Institute, P.O. Box 7084, 02041 Kampala, Uganda

[2] University of Greenwich, Principal Scientist (Vector entomology), Natural Resources Institute Chatham Maritime, ME4 4TB, Kent, United Kingdom

[3] International Institute of tropical Agriculture, IITA-ESARC, P.o Box 7878 Kampala, +256 Kampala, Uganda

[4] Natural Resources Institute, University of Greenwich, Chatham Matitime, Kent, ME4 4TB, 02044 London, United Kingdom

Attraction of *Bemisia tabaci* to cassava plants, field colonization and adult settlement on leaf surfaces were investigated on cassava mosaic-affected and symptomless plants of three cassava varieties: Nase 4, Nase 9 and Bao (local landrace). Generally, more adults were trapped on symptomless potted plants smeared with insect adhesive compared to infected ones, the number being significantly higher ($P< 0.001$) only on Bao. On un-smeared plants, the adult population was significantly higher ($P< 0.001$) on CMD-affected plants than on healthy ones. This indicated preference and higher retention of adults on infected material. Similarly, field colonization of plants by migrant whitefly adults assessed within two weeks after sprouting showed a preference for infected plants compared to healthy ones. Digital pictures of the under surface of the third open leaf from the apex showed characteristic alignment of whitefly adults along the midrib on healthy plants and aggregation on green leaf tissue on symptomatic plants. Adult density per unit green leaf was significantly higher ($P< 0.001$) for infected compared to healthy plants and was two and seven fold for Bao and Nase 9, respectively. The significance and implications of such behaviours in relation to spread of the epidemic are discussed.

First report of physical damage to cassava caused by the whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Sternorrhyncha: Aleyrodidae)

Legg, J.P.[1]; Mallowa, S.[2]; Sseruwagi, P.[3]

[1] IITA-ESARC, Uganda and NRI, UK. IITA, c/o Lambourn and Co. Ltd., Carolyn House, 26 Dingwall Rd., CR9 3EE Croydon, United Kingdom

[2] IITA-ESARC, PO Box 7878 Kampala, Uganda

[3] IITA-ESARC, Uganda, c/o Prof. Judy Brown, Dept. of Plant Sciences, Forbes Building, Rm. 303, University of Arizona, AZ 85721 Tucson, Arizona, USA

Cassava is a major food staple crop throughout much of sub-Saharan Africa. During the 1990s, production was devastated in parts of East Africa following the spread of a pandemic of severe cassava mosaic virus disease (CMD). Associated with the pandemic were boosted populations of the whitefly vector, *Bemisia tabaci*. Hypotheses proposed for the increased whitefly populations include a synergistic interaction between CMD-diseased cassava and *B. tabaci* and the occurrence of a distinct pandemic-associated *B. tabaci* genotype. In recent years, however, increasingly large *B. tabaci* populations have become evident on disease-free CMD-resistant varieties introduced to control the CMD pandemic. In this paper, we present evidence both for the dramatic increase in whitefly abundance on a local CMD-susceptible variety, in addition to the first published information describing physical damage to cassava caused by *B. tabaci. Bemisia tabaci* adult populations recorded on blocks of the local CMD-susceptible variety Bao, at Namulonge, near Kampala, Uganda, ranged from 0.2-0.7 per top five leaves at eight months after planting in three trials run between 1992 and 1994. In 1998 and 1999, however, *B. tabaci* populations recorded in repeat trials using the same variety were 3.4 and 89.4 respectively. CMD infection of the initially CMD-free cassava plantings ranged from 0.2-2.2% in the 1992-1994 trials, but increased to 92.7 and 99.6% in the1998 and 1999 trials respectively, following the passage of the severe CMD pandemic in 1995. Numbers of fourth instar *B. tabaci* nymphs recorded on leaves of one local CMD-susceptible and nine elite CMD-resistant varieties at four months after planting in a trial planted in October 2001, averaged from 240 (for the local susceptible) to 1574 (for Nase 10) representing densities per cm^2 of from 1.8 to 16.8. At these population densities, symptoms of physical damage were recorded from all varieties, though varying in intensity. Symptoms included the development of sooty mould on leaves, petioles and stems, reduction of leaf size, distortion of leaf shape, a mottled chlorosis caused by adult feeding on upper leaves and general plant stunting. Whilst the reasons for this apparent population explosion of *B. tabaci* on cassava remain unclear, it is evident that the superabundance on resistant varieties represents a significant threat to their wider utilization in efforts to control the CMD pandemic. As such, greater research attention needs to be directed towards managing *B. tabaci* populations on cassava both in Uganda and the wider East and Central African region.

Oviposition hosts of the whitefly *Bemisia tabaci* and its parasitoids

Dhanapala, M.G.

Regional Agricultural Research & Development Centre, Diyathalawa Road, Bandarawela, Sri Lanka

Survey was conducted to identify the hot spots of whitefly populations in the area and the host plants that are preferred by whiteflies and its parasitoids. Forty plant species belonging to 10 families were exposed to the *Bemisia tabaci* under glass house conditions and field conditions for recording oviposition and nymphal emergence to investigate the weed and crop reservoirs of the whitefly and its parasitoids under field conditions. Severe field infestation occurred in crops such as *Phaseolus phaseoli*, *Solanum melongena, Salvia* spp. *Fuchsia* spp., and *Titonia diversifolia* and on several other weed species such as *Crassocephalum crepidioides, Emilia sonchifolia*, and *Euphorbia heterophylla*. Whitefly population was very high in locations where year round staggered cultivation of vegetables are practiced or other hosts are present. Two different biotypes of the whitefly could be discovered. Under green house conditions damage is more severe than in the open field, though oviposition was observed on 35 host plants belonging to 10 families, nymphal emergence was observed on only 18 plant species. The oviposition and nymphal emergence was high on *Phaseolus phaseoli, Salvia splendis, Fuchsia* spp., parasitism due to *Eretmocerus mundus* and *Encarsia bimaculata* and *Encarsia sophia* was found on beans, eggplant and on *Fuchsia* sp. Higher oviposition, nymphal emergence and higher adult populations occurs in crops grown under greenhouses than in the open field. New biotypes infest most of the crops growing in the area and are free from any parasitoid infestation.

Current status of *Bemisia tabaci* in Croatia

Zanic, K.[1]; Cenis, J. L.[2]; Simón, B.[2]; Kacic, S.[1]; Simala, M.[3]

[1] Institute for Adriatic Crops and Karst Reclamation, Put Duilova 11, P.O. Box. 288, 21000 Split, Croatia
[2] CIDA (Centro de Investigación y Desarrollo Agroalimentario), 30150 La Alberca-Murcia, Spain
[3] Institute for Plant Protection in Agriculture and Forestry of Republic of Croatia, P.O. Box. 206, Zagreb, Croatia

The first record of *Bemisia tabaci* in Croatia was in 2000 when it was identified in Split County. The main part of pest population cycle occurred on poinsettia (*Euphorbia pulcherrima*) in glasshouses. Its presence was also confirmed in outdoor conditions, on cultivated and wild host plants, period May – November. Although the quarantine measures had been applied, the pest overwintered and spread on remaining poinsettia plants in the protected conditions. Given that this pest characteristics have not been studied in Croatia, this paper reviews its distribution, host plant range, population dynamics on alternative hosts and biotype status. Monitoring of *B. tabaci* presence was organized in Croatia during the period May - December 2001 in collaboration with the Republic Institute for Plant Protection in Agriculture and Forestry - Zagreb. Yellow sticky traps and direct observation methods were used. The pest mainly invaded Adriatic districts with mild Mediterranean climate even it was found in Subpannonian district (Zagreb and Varazdin) in protected conditions. Thirty plant species were recorded as pest hosts in the Middle Adriatic Region. It infested vegetable crops like cucumber, melon, squash, egg plant, pepper and tomato and poinsettia on the first place between ornamental plants. Important wild hosts were *Convolvulus tricolor* and *Solanum nigrum* during the summer season. It was the reason why pest population dynamics was studied on these alternative hosts during 2002 in Split County. Leaf samples were collected weekly (30 leaves of either host) from the beginning of June, what was the period of *B. tabaci* appearance in outdoors conditions. Number of adults was recorded in outside conditions while immature stages were counted under the stereomicroscope in the laboratory. The presence of pupae parasited by unidentified parasitoids was also recorded. Pest population trend was presented graphically. In order to collect the first information on the *B. tabaci* biotype status in Croatia, adult samples were collected during 2001 in outdoor conditions on wild hosts (suburb of Split, places Vis and Komiza on island Vis) and greenhouse conditions on cultivated hosts (Split, Rogoznica and Pula). Seven individuals from Split were analyzed by sequencing of the COI gene of mtDNA. The sequences obtained showed the highest similarity (99%) with populations from Morocco and Spain.

Preference to *Bemisia tabaci* biotype B oviposition in cowpea genotypes

Costa, N.; Santos, T.; Boiça Júnior, A.

Universidade Estadual Paulista/FCAV, Dep. de Fitossanidade, Jaboticabal Campus, Via de Acesso Prof. Paulo Donato Castellane, s/n., 14884-900 Jaboticabal - São Paulo, Brazil

The oviposition preference to whitefly, *Bemisia tabaci* (Gennadius) biotype B, on cowpea genotypes (*Vigna unguiculata*) in free and no-choice tests was evaluated. The genotypes IPA 206, Canapu, Corujinha, Cariri Hilo Preto, Sempre Verde, Cariri Hilo Vermelho, CNCX 405 17F, TE 90 170 76F were sowed in plastic glasses (500 ml) over organic substratum and maintained in glasshouse until emergence of true leaves. In both experiments, it was utilized a randomized block design in five replications for each genotype. In free choice test, each block was constituted for a metal cage covered by anti-aphid textile containing one plant and it was released 800 whitefly adults on the interior of this cage. In no-choice test, each vase containing one plant was protected for cilindrical cage and it was released 100 whitefly adults. For both tests, four days after infestation, picked up three folioles of superior part of each plant and this were conducted to the lab for counting the number of whitefly eggs per cm^2 in each genotype, utilizing a stereomicroscope. In free choice test, Canapu was the most preferred for oviposition (41.1 eggs/cm^2) and in no-choice test Cariri Hilo and Canapu were the most laid, differing of Cariri Hilo.

Non-preference to *Bemisia tabaci* biotype B oviposition in cotton cultivar

Boiça Júnior, A.[1]; Toscano, L.C.[2]; Santos, T.[1]

[1] Universidade Estadual Paulista/FCAV, Dep. de Fitossanidade, Jaboticabal Campus, Via de Acesso Prof. Paulo Donato Castellane, s/n., 14884-900 Jaboticabal - São Paulo, Brazil

[2] Universidade Estadual de Goiás, Rodovia GO 330 - Anel Viário, 75780-000 Ipameri - Goiás, Brazil

The influence of cotton cultivar with different trichome density on oviposition preference to *Bemisia tabaci* biotype B was evaluated. It was used Deltapine Acala 90, CNPA 7H and Antares cultivars in free and no-choice tests. The number of whitefly eggs per cm^2 per leaf in each cultivar was determined and calculing the oviposition preference index. Deltapine Acala 90 was the most preferred for oviposition, 6.11 eggs/cm^2 per leaf in relation to Antares, 0.49 eggs/cm^2 per leaf, in free choice test. The oviposition preference of whitefly was not influencied by cotton cultivars in no-choice test. The oviposition preference index classified Deltapine Acala 90 like stimulant toward CNPA 7H (neutrality pattern), while Antares was classified like deterrent to insect oviposition. It was concluded that Antares was the least preferred to oviposition, in free choice test, showing oviposition non-preference type to *B. tabaci* biotype B. There was not influence of cotton cultivars on whitefly oviposition behaviour in no-choice test.

Temporal distribution and natural enemies of *Bemisia tabaci* Gennadius (Homoptera- Aleyrodidae) in Algeria

Benmessaoud-Boukhalfa, H.; Benmessaoud, K.

Institut national agronomique, Département de zoologie agricole et forestière, 16200 Alger, Algeria

The seasonal distribution on tomatoes of adults and 4th instar larvae of *Bemisia tabaci* were monitored during a four year period, in order to assess the pest and natural enemies population dynamics in Algeria. Three overlapping generations were recorded. The first generation lasted 8 to 9 weeks with an average of 17 adults and 2244 nymphs per plant. The second generation lasted 7 to 8 weeks with an average of 103 adults and 665 nymphs per plant. And the third generation lasted 5 to 6 weeks with an average of 211 adults and 343 nymphs per plant. Algerian *B. tabaci* is biotype Q in the north and the south area. Natural enemies collected on *B. tabaci* were the parasitoids *Encarsia formosa*, *Encarsia tricolor* and *Eretmocerus mundus*, and the predators *Macrolophus caliginosus* and *Nesidiocoris tenuis.*